DRAFT INTERNATIONAL STANDARD ISO/DIS 16458

ISO/TC **20**/SC **14** Secretariat: **ANSI**

Voting begins on **2002-05-30** Voting terminates on **2002-10-30**

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Space systems — Unmanned spacecraft transportation — General requirements

Systèmes spatiaux — Transport des véhicules spatiaux non habités — Exigences générales

ICS 49.140

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

ISO 16458 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

Introduction

International cooperation in space system design and operation determines how a spacecraft (SC) and its hardware are transported, such as:

a) transportation of special hardware for setup and operation of the SC from other countries;

b) transportation of the SC with hardware for integration with the launch vehicles.

Since the problems of ground transportation of the SC and their hardware will not hinder the development of international cooperation, therefore:

a) transportation should not require special preparation of the SC and its hardware;

b) transportation should be based on the normal transport facilities.

It would be ideal to develop international transportation requirements for all SC and all types of transportation modes. However, development of such requirements for all areas and all SC of other countries is very big problem; so the following general requirements should be established initially:

a) the environment for the SC transportation;

b) the loads from all transportation modes;

c) the rules for the SC loading, transportation, and unloading.

This International Standard contains a list of requirements for different types of transport (rail, road, air, and water).

Space systems — Unmanned spacecraft transportation — General requirements

1 Scope

This International Standard applies to unmanned spacecraft and its supporting hardware and establishes the requirements for transportation by rail, road, air and water and as a part of a launch vehicle. This standard establishes the requirements for special containers and loading/unloading operations meant to safeguard unmanned spacecraft and its supporting hardware during transportation.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 14303:20__, *Space systems — Spacecraft to launch vehicle interfaces.*

ISO 15863:20__, *Space systems — Spacecraft to launch vehicle interface control document.*

ISO 17401:20__, *Space systems — Spacecraft interface requirements document for launch vehicle services.*

3 Symbols and abbreviated terms

LC launch complex

OD operational documentation

SC spacecraft

TS technical specification

4 Transportation requirements

4.1 General provisions

4.1.1 Special containers or railway cars

SC transportation to a launch site or maintenance structure shall be carried out in special containers or special devices designed to ensure the safety of the SC and the necessary transportation conditions (e.g. temperature, humidity, etc.) specified in operational documentation (OD).

4.1.2 Mechanical loads

During transportation and loading/unloading operations, structural loads act on SC. These loads depend on SC securing methods, the stiffness of the transport device, and the loading/unloading facilities used. The limiting values and duration of the loads shall be specified in documentation of the SC developer.

4.1.3 Types of transport

The types of transport, as well as the requirements for transportation, shall be specified in a technical specification (TS) on the launch complex (LC) or SC.

4.1.4 Components

Components, as well as spare parts, accessories, and tools, may be transported under the same conditions as the SC. Additional requirements may be specified in the TS on the LC or SC.

4.1.5 Safety requirements

Spacecraft shall be completely secured during transportation (except when transported as part of the launch device). Pyrotechnical components shall be in a safe inactive condition. The current International Transportation Regulations and the International Safety Constraints that exist under the authority of the United Nations shall be observed.

4.1.6 Purge pressure

The components of SC that are sensitive to moisture shall be supplied with a purge pressure during transportation as specified in the OD.

4.1.7 Grounding

SC and container shall be grounded during transportation in accordance with the spacecraft OD.

4.2 Requirements for special containers and control over transportation conditions

4.2.1 Container

A container shall protect the SC from damage during transportation, loading/unloading operations, or storage, as well as ensure protection against the natural environment.

4.2.2 Lifting devices and tie-down points

Lifting devices (yokes, shackles, etc.) and pickup/tie-down points shall be provided for the lifting and securing containers on a transportation device. Intermediate elements for securing the container by lifting devices (yokes, shackles) on the transportation device shall be in accordance with the requirements of the OD.

4.2.3 Container dimensions

Dimensions of a container shall be in accordance with the dimensional outlines of rolling stock adopted in international and/or national practice.

4.2.4 Design requirements

The design of a container shall ensure:

a) dust and moisture tightness, protect against water penetration and shall ensure that environment parameters inside a container are maintained within the established limits;

b) air pressure inside a container is equal to the environment at air pressure or higher air pressure in accordance with that specified in the OD;

c) relative air humidity inside a container is not more than 80 %, and the absolute humidity is not more than 0,019 kilogram per cubic meter (kg/m^3) or in accordance with the spacecraft OD, if the latter is more stringent;

d) temperature inside a container is from –50 ^oC to + 50 ^oC or in accordance with the spacecraft OD, if the latter is more stringent;

e) protection against penetration of rodents and insects is provided;

f) dust-generating materials are not used;

g) a metal coating or metal container provides protection against static electricity.

4.2.5 Thermal containers

Thermal containers shall ensure the following transportation conditions:

a) temperature inside a container is in accordance with the spacecraft OD;

b) pressure is from 93 kPa to 113 kilopascal (kPa), or in accordance with the spacecraft OD;

c) relative humidity is a maximum of 80 % or in accordance with the spacecraft OD, if the latter is more stringent;

d) air cleanliness in a container is in accordance with the OD.

4.2.6 Shock absorption system

In order to reduce structural loads acting on SC during transportation down to acceptable values, a container shall be equipped with a shock absorption system or other load-reduction systems when required to meet the technical specification.

4.2.7 Monitoring and recording

For transportation of SC in a container, the monitoring and recording of transportation conditions shall be performed when required by the TS. In order to ensure monitoring of SC parameters without opening the container, the container design shall provide for remote monitoring. Volumes and permissible ranges of values of monitored parameters of transportation conditions shall be stipulated in the OD.

4.3 Transportation by rail

4.3.1 Requirements for transportation

SC transportation by rail shall be carried out in accordance with rules adopted in international or national practice.

4.3.2 Loads

The location and orientation of the SC (vertical, horizontal, etc.), securing of SC in a container, and the shock absorption system shall be designed to accommodate the following loads imposed by the railway cars:

a) along direction of motion: $n_X \leq \pm$ 29 metres per second squared or in accordance with the spacecraft OD;

b) vertical to the plane of motion: $n_Z \leq$ **(-** 10 $\pm$ 17) metres per second squared or in accordance with the spacecraft OD;

c) horizontal across the direction of motion in the plane of motion: $n_y \leq \pm 17$ metres per second squared or in accordance with the spacecraft OD.

4.3.3 Approval of deviations

Deviation of overall dimensions of a container carrying SC from overall dimensions of the rolling stock shall be approved by railway authorities.

4.3.4 Precautions

During SC transportation, abrupt jolts, jerks, and disconnection of inter-car joints of the braking system are not allowed. Railway cars and platforms carrying SC shall not be subject to descending from sorting gravity yards and shall require higher caution measures during manoeuvres.

Speed with which a locomotive (with railway cars or without them) approaches immobile railway cars with SC shall not be more than 0,8 metre per second (m/s). Speed with which detached or separate railway cars approach a hump yard as well as during maneuvers in jolts shall not be more than 1,4 m/s. Do not hump.

Railway cars carrying SC shall not be included in a train containing explosion hazards or chemically aggressive cargoes.

Railway cars carrying SC shall have signs and inscriptions on them that indicate precautions necessary for the descending from rail yards, abrupt jolts during manoeuvres, or detaching escort and protection railway cars.

4.3.5 External inspection during stops

During stops en route, external inspection of a transportation device, container, and container-securing assemblies shall be performed. The procedure and frequency of the inspection shall be determined by the OD on the SC.

4.4 Transportation by road

4.4.1 Working condition

Prior to loading/unloading operations, the working condition of the transportation device shall be inspected. Prior to first movement, the security of the container carrying the SC shall be inspected.

4.4.2 Loads

The location and orientation of SC (vertical, horizontal, etc.), securing of SC in a container, and the shock absorption system shall be designed to accommodate the following loads imposed by the motor vehicle:

a) along the direction of motion: $n_x \leq \pm$ 20 metres per second squared or in accordance with the spacecraft OD;

b) vertical to the plane of motion: $n_z \leq$ **(-**10± 20) meters per second squared or in accordance with the spacecraft OD;

c) horizontal across the direction of motion in the plane of motion: $n_y \leq \pm$ 12 meters per second squared or in accordance with the spacecraft OD.

4.4.3 Driving regulations

During SC transportation by road, traffic and driving regulations shall be strictly enforced. Under hard driving conditions (rain, snow, fog, dust storm, etc.) as well as in bad road conditions (mud, ice, roughness), the speed shall be reduced to a minimum and sudden braking and sudden starting shall not be allowed.

4.4.4 Periodic checks and inspections

At a distance of 1 km to 1,5 km after the beginning of movement and further on at each 150 km of the journey, or in accordance with the spacecraft OD, the security of the container carrying the SC shall be inspected, and an inspection of the motor vehicle shall be performed. Special attention shall be paid to:

a) securing of the container carrying the SC on the transportation device;

b) the condition of the steering system, brakes, and coupling of the transportation device, as well as devices and equipment ensuring safety of movement (signaling, lighting devices, etc.);

c) the connections of pneumatic brakes and electrical equipment of tractor-drawn devices;

d) security of the wheels, the condition and securing of springs, shock absorbers, and torsion bars.

4.5 Transportation by air

4.5.1 Limitations

Transportation of the SC by air shall be carried out without limitation of speed and distance. The number of takeoffs and landings and the total flight times shall be determined by the TS on the SC.

4.5.2 Loads

The location and orientation of the SC (vertical, horizontal, etc.), securing of SC in a container and the shock absorption system shall be designed to accommodate the following loads imposed by the transport aircraft:

a) along the direction of motion: $n_x \leq \pm$ 14 metres per second squared or in accordance with the spacecraft OD;

b) vertical to the plane of motion: -39 metres per second squared $\leq n_z \leq$ - 2 meters per second squared or in accordance with the spacecraft OD;

c) horizontal across the direction of motion in the plane of motion: $n_y \leq \pm$ 5 metres per second squared or in accordance with the spacecraft OD.

4.5.3 Inspection

Prior to each takeoff and after each landing, external inspection of the container and its tie-down assemblies in the aircraft shall be performed. The inspection procedure shall be determined by the OD on the SC.

4.5.4 Static and vibration accelerations

In order to ensure SC transportation by aircraft transport, the latter shall be capable of withstanding the maximum static and vibration accelerations, as well as the atmospheric pressure differentials arising during the normal and emergency flying regime and descent of the transport aircraft.

4.5.5 Loads on assemblies

Assemblies securing the SC in a container and the container itself shall be designed to withstand the structural loads acting on them during an emergency landing of the transport aircraft.

4.5.6 Setting values

Values of loads, flight altitude, and descent speed, as well as requirements to SC and its securing, shall be set in accordance with specifications for the equipment and cargoes meant for transportation by transport aircraft for each type of aircraft.

4.6 Transportation by water

4.6.1 Limitations

SC transportation by water shall be carried out without limitation of speed and distance in accordance with regulations on cargo transportation in force for sea and river transport. For this purpose, its use of sea and river vessels that accommodate a SC on board may be used.

4.6.2 Loads

The location and orientation of SC (vertical, horizontal, etc.), securing of SC in a container and the shock absorption system shall be designed to accommodate the following loads imposed by the transport vessel:

a) along the direction of motion: $n_X \leq \pm$ 6 metres per second squared or in accordance with the spacecraft OD;

b) vertical to the plane of motion: $n_Z \leq$ **(-** 10± 16) meters per second squared or in accordance with the spacecraft OD;

c) horizontal across the direction of motion in the plane of motion: $n_Y \leq \pm$ 11 meters per second squared or in accordance with the spacecraft OD.

4.6.3 Tying down containers

Containers carrying SC shall be safely tied down in accordance with the OD on the SC using additional devices (braces, ropes, wire, yokes, wooden pads, beams, etc.) specified by this documentation.

4.6.4 Protection from water

Containers carrying SC placed on an upper deck of a ship shall be protected from atmospheric precipitation and sea water or river water.

4.6.5 Inspection of containers

The tie-down condition of containers carrying SC shall be checked not less than 4 times per 24 hours (the first inspection shall be 0,5 hour to 1 hour after the beginning of movement) or in accordance with the OD. In stormy weather the containers carrying SC should be under constant observation.

4.6.6 Loading and unloading requirements

During loading of containers carrying SC on board a vessel and during their unloading, requirements for conducting and maintaining control over loading/unloading operations stipulated in subclause 4.1.3. of this International Standard shall be met.

4.7 Transportation of SC as part of a launch vehicle

4.7.1 Distance and speed

When transporting a fully assembled SC from an assembly area to a launch site, the distance shall not exceed 100 km. The speed shall not exceed 2,8 m/s and shall be in accordance with the OD.

4.7.2 Transportation conditions

During transportation of SC as part of a launch vehicle, transportation conditions specified in the OD on the SC shall be in accordance with ISO 14303, reflected in accordance with the IRDFF by ISO 17401 and controlled in accordance with the ICD by ISO 15863.

4.8 Requirements for conducting and maintaining control over loading/unloading operations

4.8.1 Crossbars and cranes

During loading of SC into a transportation container and onto a transportation device, special crossbars and cranes, having slow lifting speeds and transferring mechanisms and equipped with two brakes acting independently from each other, shall be used.

4.8.2 Documents of the crossbars and containers

Prior to the beginning of loading/unloading operations, documents (passports or record books) on the cranes, crossbars, and containers certifying their fitness for the lift shall be checked.

4.8.3 Rigging devices

During loading/unloading operations, rigging devices shall be attached to all the points meant for the container lifting. All rigging devices shall have been satisfactorily load tested prior to use.

4.8.4 Tag lines

For turning, as well as preventing the container carrying the SC from spontaneous turning, lifting, or transfer, ropes (tag lines) shall be used (not less than two per container).

4.8.5 Lifting/loading equipment

Lifting/loading equipment may be removed from a container or a crane hook only after the container has been set up safely on its bottom.

4.8.6 Flammable substances

Highly inflammable substances shall not be within 10 metres (m) of a loading/unloading site.

NOTE The requirement does not apply to the fuel contained in the SC.

4.8.7 Cleaning the site

A loading/unloading site shall be cleaned of dirt, sand, mud, water, snow, ice, and other debris.

4.8.8 Freezing conditions

Spacecraft containers exposed to freezing conditions may become frozen to the floor or supporting structure. The SC container shall not be lifted under these conditions until such time as an unrestrained lift can be ensured.

4.8.9 Signs and inscriptions

During loading /unloading and transfer of crates with assembly parts of SC, requirements for methods of handling cargoes (including manipulation signs and caution inscriptions) shall be met.

4.8.10 Earthing rods and antistatic bracelets

Prior to the beginning of the work, personnel involved in loading/unloading operations shall, with an interval of not more than 30 minutes, touch by hand an earthing rod in order to relieve static electricity or shall wear antistatic bracelets.

4.8.11 Mechanical loads control

During loading/unloading operations, control over mechanical loads acting on SC shall be maintained, in cases specified in the OD on the SC.

4.8.12 Thermal conditioning outside a thermally conditioned building

During loading/unloading operations with SC requiring thermal conditioning outside a heated building, the OD on the SC shall specify the maximum allowable time of being without those conditions.

4.8.13 Nonthermal conditioning container

After SC transportation in a container without thermal conditioning at temperatures below 0 ^{o}C, the container shall be opened only after it has been at an indoor temperature for a time interval specified in the OD on the SC.

4.9 Verification of transportation and loading/unloading conditions

SC transportation and loading/unloading conditions shall be verified. The following parameters shall be subject to verification:

a) mechanical loads acting on the container in the fixation points and

b) pressure, temperature, and humidity inside of the container.

Each case of exceeding the set values of the previous parameters or exceeding the allowable set range shall be recorded together with the time when this event occurred. On the basis of the results of these recordings, a transportation package shall be prepared, containing a record of all violations of the set conditions as well as analysis of the reasons and seriousness of such violations.